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Towards a Digital Lean Hospital: Concept for a Digital Patient Board and Its Integration with a Hospital Information System

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Abstract

Lean management applied to healthcare aims at creating maximum value for patients by reducing waste and waits. It puts the patient's needs center stage, emphasizes employee involvement and continuous improvement. To realize this, visual tools such as the huddle board or the patient board are implemented in hospital wards. The boards are currently realized by whiteboards or flipcharts, which leads to duplicated data entries and loss of information. The objective of this work is to introduce a concept for digitalizing the patient board and integrate with a hospital information system (HIS) for improved data availability. Data on appointments, personnel planning and master patient data can be directly accessed from the HIS database. A digital patient board has several benefits: data can be collected from information systems, making it obsolete to record information several times. Even more functionalities, in particular, those supporting the communication between a patient and a healthcare team can be included by means of a digital board which improves patient involvement.

Keywords:

Health Communication, Hospital Information Systems, Patient Care Management

Introduction

To reduce costs, healthcare providers try to improve their outcomes while simultaneously achieving greater efficiency. One prominent method is lean management; it promises improved quality, capacity, and safety while limiting costs [1; 2]. Lean is a management philosophy that helps to create maximum value for patients by reducing waste and waits. It puts the patient's needs center stage, focuses on employee involvement and continuous improvement [3]. Originally developed for Toyota Production Services, lean has been applied to various industries and is now conceptually described as "an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability" [4].

Visual means such as the huddle board or the patient board are used as tools to implement lean principles into practice [5; 6]. The patient is placed in the middle of all processes. By means of a patient board, be it a flipchart, whiteboard or a customized markerboard, installed in a patient's room, each patient is continuously informed about the course of the stay. On that particular board, a patient's needs and requests regarding the treatment process can be recorded manually during consultation with a doctor (for example, the date of discharge). In addition, the patient can also see what time the nursing staff will check the next time, who is responsible for him or her on a particular day or which examinations will take place on the current day. This information board creates transparency for the patient. Daily objectives defined by physiotherapists, physicians or nurses motivate to do suggested exercises continuously.

There are commercial tools available to support patient communication such as the communication boards from ID Signsystem [10] which are not digital solutions, but customized markerboards. MyCareBoard is a digital whiteboard distributed commercially by the company Lincor [11]. This board is developed for inpatients. It shows the latest laboratory data, provides access to social media tools and shows contact persons for the day. MyCareBoard provides many functionalities that go beyond the lean principle which renders the interaction much more complex. Since the inpatients in our collaborating hospital are often above 60 years, we believe that – in contrast to MyCareBoard - our digital patient board should focus on the provision of relevant information and on a well-defined set of functionalities.

Sehgal et al. found out that whiteboards placed in patient rooms have the potential to improve teamwork, communication and patient care [12]. They can improve patient experience and coordination of care between patients, their family members and hospital staff. Dry-erase whiteboards were used at the bedside but led to frustration for nursing staff, nursing leadership, hospital administrators and patients. Studies showed that one major reason is that these whiteboards fail because pens are unavailable when needed [12].

The use of a whiteboard version of a patient board was evaluated in a project at the Biel hospital center [4-7]. It was found that patients appreciate the visual representation of their daily routine and the planned appointments shown on the patient board. Some weak points were that data must be recorded several times on the different boards, in the HIS and on the patient board. Furthermore, data protection was not given since the current board is placed visibly to all visitors in the patient room.

To overcome these limitations, we introduce a concept for digitalizing the patient board and integrating it into the hospital workflow. Furthermore, we introduce our prototype for a digital patient board. The objective of a digitalized patient board is to increase data availability for patients, improve patient involvement, patient experience and provide a means for asynchronous information exchange and communication with a patient.

Methods

Development Process

Requirements were assessed in discussions with the leading nurses, the head of the nursing department and an IT manager of a Swiss hospital. In an iterative process accompanied by stakeholder discussions, a concept was developed to replace the current patient board realized as a whiteboard by means of a digital solution meeting the above-mentioned requirements. The interfaces to existing information systems were analysed. Finally, a prototype of a digital patient board was implemented considering the requirements from the orthopedic ward. Feedback on the system was retrieved in discussion with nurses and patients (see the section on usability test results).

Lean Management on the Partner Hospital

The hospital *Spitalzentrum Biel* involved in this work adapted the Seattle model of a lean hospital. Among other methods, they apply lean in their orthopedic and gynecology ward. Each ward is split into four zones with a zone comprising 4 patient rooms. In the daily personnel planning, nursing staff is assigned to the single zones. Over the day, nurses only address tasks within the assigned zone. Every hour, they go through the bedrooms in their zone and address the patient issues.

The lean principle is applied to support planning and communication among others by implementing three different boards (flowboard, huddle board, patient board). They are available as whiteboards on which hospital staff can write relevant information. The flowboard is located in each zone of a ward and is used by caregivers. They meet to plan their hourly rounds to the patients and allocate tasks. This information is written on the board. All professional groups of all zones meet twice a day at the huddle board to discuss the daily routine on the ward. The huddle board supports the communication and planning of the tasks in the ward.

The patient board is placed in the patient rooms. By means of a flipchart/whiteboard, each patient is informed about the course of his or her stay. A mobile care trolley was made available to the nursing staff for the hourly rounds. This is a mobile workstation for care to avoid unnecessary interruptions in the working process with patients as well as long distances. It contains a laptop and the most important materials as well as medications [7].

Results

In this section, we introduce the concept for digitalizing the patient board and integrating it with the system and process landscape of a hospital. Further, we describe the functionalities and components of our prototype of the digital patient board.

Requirements

A main requirement for digitalization of the patient board is to provide the same content as the one available on the existing whiteboard patient board, but in a digital format. Information should be accessible through a web application running on two devices: on a touch screen placed in the patient room and a tablet application accessible through a tablet. Nurses, physicians and patients interact with the touch screen. They should be able to enter and modify data. Wherever possible, relevant data items have to be retrieved from existing information systems and shown on the patient board. The information should be displayed in a suitable way for patients and health professionals.

The tablet version is only designed for use by patients. It should enable the patient to enter notes on the daily physiotherapeutic goal and to ask questions. Furthermore, the patient should have access to responsible care providers, appointments, daily physiotherapeutic objectives and the specified requests and needs. Data security has to be ensured in both devices.

Concept

Our concept for digitalizing the patient board and integrating it with the information system environment consists of several devices (Fig. 1).

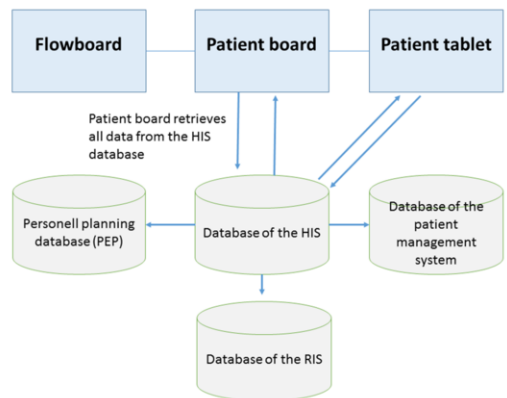

Figure 1: System overview: The patient board is the central data access screen. It is connected to the database of the hospital information system. A subset of the data is available through the patient application using a patient tablet.

The **patient tablet** with patient application is designed for use by patients during their stay at the hospital and allows, for example, accessing the individual daily, physiotherapeutic goal and a progress line.

The **patient board** is a web application accessible through a touch screen located in the patient room. It provides data access for doctors, nurses and patients.

The **patient portal** is an application for patients to be used inside or outside the hospital, mainly providing information on the stay.

Table 1 summarizes the type of information that is available through the different devices. Figure 1 shows the interactions between the different devices (flowboard, patient board and patient tablet) with the HIS and connected information systems. In this work, we are focusing on the digital patient board. However, the flowboard is included in the concept since it is currently under development.

All relevant data shown on the patient tablet or patient board is retrieved and stored in the HIS and is accessed by the different devices listed above. The information shown on the patient board is taken from the HIS database which in turn has interfaces to other databases. For example, from the personnel planning system PEP, the responsible physician and nurse and their period of service, are taken. This information can be shown on the digital patient board in order to select the responsible physician according to the shift planning. In future, additional boards that allow showing the result from shift planning directly on the patient board can be integrated. From

the radiology information system (RIS), scheduled radiology examinations of a patient are collected. The patient master data and case data are taken from the patient administration system. In future work, we will also digitize the flowboard that will also be connected to the patient board and HIS.

Table 1: Information available on different devices

Device	Information provided
Flowboard	Patient ID, surname, first name, patient room number, upcoming examination (where, when) shown in a flow chart
Patient board	Date, surname, first name, date of birth, language, responsible physician and nurses, upcoming examinations, goals, medication, admission date, discharge date
Patient tablet	Responsible physician and nurses, upcoming examinations, physiotherapeutic goals, request and needs from the patient

Patient Board and Patient Application

The electronic patient board was implemented as a web application, specifically implemented for the orthopedic ward of the collaborating hospital. We developed the patient board in two languages (French and German). Languages can be added easily in future, addressing the fact, that inpatients might neither speak German nor French.

When the application is started, the functionalities differ slightly depending on the platform used and access rights. Accessed through the touch board (referred to as patient board in Figure 1) by health professionals, data can be manipulated. More specifically, patient master data can be accessed and individual data records such as the therapeutic goal of the patient board can be modified. Functionalities of the touch screen application for the nurses and physicians include:

- Entering dietary restrictions, responsible care providers, patient needs,
- Specifying physiotherapeutic goal,
- Changing mobilisation schema (Figure 3),
- Entering discharge date,
- Retrieving examination and treatment appointments from relevant information systems.

The system can only be accessed by authentication with a password or patient barcode.

When data is accessed by a patient through a patient tablet, the individual progress is shown on the patient board; questions and needs can be formulated and stored for indirect communication with the healthcare team. In this way, the patient is provided with a platform for recording requests that cannot be addressed immediately by the care team. Contact persons of the healthcare team are listed on the screen. Additionally, the patient application displays a progress curve based on the mobilization scheme and daily goals of the physiotherapy. The display can be personalized so that a patient only sees data that is of importance for him. This ensures that patients are not overloaded by information. In order to make entries in the patient tablet app, patients must authenticate themselves with an integrated barcode scanner. The scanned bar/QR code is compared to the tablet UUID stored in the database and assigned to the patient. Figure 2 shows a screen of the patient application.

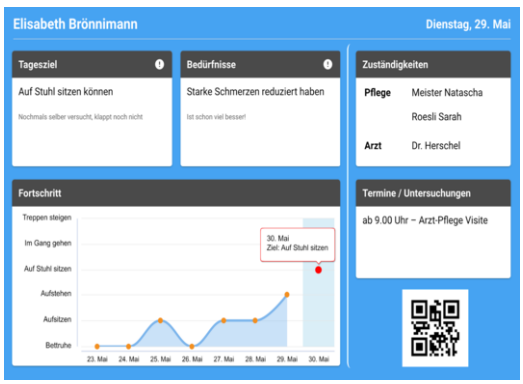

Figure 2. The digital patient board shows a progress line with respect to the mobilization progress, daily goal (Tagesziel), needs (Bedürfnisse), responsible nurses and clinicians, or appointments. Elisabeth Brönnimann is a fictitious character.

Figure 3: Mobilisation schema

Usability Test and Evaluation Results

To assess the usability of our digital version of the patient board in its appearances and for the different user groups (tablet vs. touch screen and patient view vs. health professional view), we performed a usability test. Nurses and potential patients have been interviewed. With "potential patients" we refer to persons that were not inpatients at the time of evaluation but are likely to become one day. They were recruited from the authors' social and work environment.

At the beginning of the test, patients were introduced to the topic of lean management and the general idea of the patient board. Afterwards, they were confronted with the app running on a tablet and a set of six tasks which had to be solved. The task included: creating, sharing and deleting a note, scanning a barcode, asking a question, opening the daily goal view and the progress bar.

Nurses assessed the patient board application that we opened in a tablet. Their tasks comprised: specifying the type of diet, adding and removing employees, specifying a mobilization goal and treatment phase, specifying a physiotherapeutic objective, adapting the date of discharge, and answering patient requests.

All participants were asked to think aloud while performing the tasks. A questionnaire with 11 statements and a 5-item Likert scale had to be completed afterwards (see Figures 3 and 4). The statements addressed usability issues (ease of use, understandability etc.) and layout.

18 potential patients and six nurses were involved in the usability test and completed the questionnaire. All participants were able to solve the tasks. The age distribution of the patients is as follows: age group 18-24 (four users), 25-44 (three users), 45-64 (seven users), 65-79 (four users).

The layout and design were well received by the potential patients. They felt comfortable while using the app and

confirmed that they could deal with the app intuitively. 72% claimed that they would be willing to use the application. The overall feedback was rather positive. The complete results from the questionnaire answered by patients are shown in Figure 4.

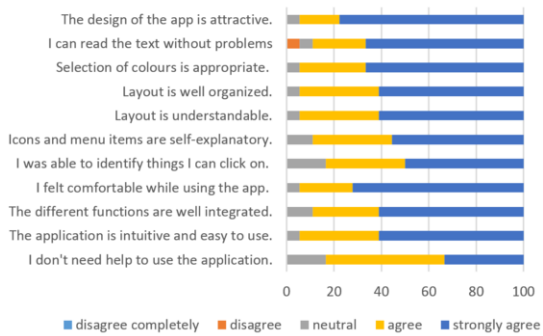

Figure 4: Evaluation results for patients (values in %)

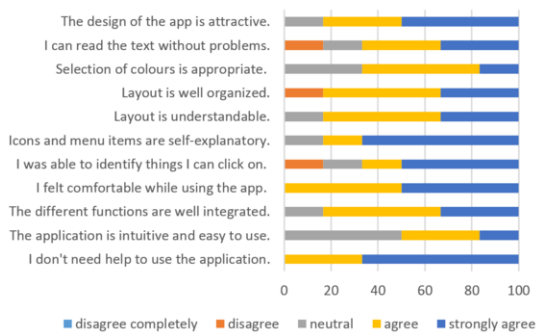

Figure 5: Evaluation results for nurses (values in %)

Compared to the patient-user group, nurses were more critical and had problems with some tasks (see Figure 5). For example, 50% of the nurses did neither agree nor disagree with the statement that the app can be used intuitively. One person had problems in dealing with the app, in particular with identifying things and reading text. However, most of the nurses confirmed they had not needed help to use the application.

Discussion

Benefits of the Digital Patient Board

Improving patient experience and coordination of care between the patients, their family members and staff is important for good outcomes in clinical care. In this paper, we introduced a concept and first prototype for a digital patient board integrated into the information system environment of a hospital. The usability test showed that patients and nurses are aware of the potentials of a digital patient board. Studies showed that patients appreciate having key information organized and available to them at a glance, leading to an increase in patient satisfaction scores [9]. Our digital patient board can facilitate in the future, consistent, standardized, and transparent communication among patients, caregivers in hospitals, medical centers and long-term care facilities.

Our implementation of a digital patient board provides features that are currently not provided by the whiteboard version, but that improve the communication between patient and healthcare team. In particular, the patient is better involved in the care process by having the opportunity to ask questions through the board. Based on the information shared by the patient, employees can respond directly to their respective needs. The patient always has an overview of his treatment and goals in mind.

One open challenge is to decide for an appropriate degree of transparency: since the interest and intellectual capacity of patients differ, the amount and kind of data displayed for the patient has to be considered carefully so as to avoid misunderstandings. Initial interviews with hospital staff show that the need for information also depends on the hospital and wards.

Another important issue is data integrity and data separation. Data integrity is ensured by the user logins and role management i.e. nurses will see more information and have more interaction possibilities when accessing the patient board with their credentials than patients.

The data flow via the corresponding interfaces between information systems in hospitals and the patient board will in future allow employees to dedicate themselves directly to communicating with the patient without having to re-enter existing information such as responsibilities or appointments on the patient board. Waiting times for the patient are reduced, employees are relieved and data integrity can be guaranteed. The economic effect still has to be proven in corresponding evaluations.

The functionalities of the patient board as tested in our prototype have been integrated into a mobile version of KISIM. KISIM is the HIS of the cooperating hospital developed and distributed by a Swiss software company CISTEC AG (http://www.cistec.ch/). KISIM mobile will provide access to the above-listed functionalities of the patient application. The data will be retrieved and stored in the KISIM database.

Problems of the Usability Test

There are some issues that influenced the usability test results. Nurses were not only focusing on their role as nurses but partially provided feedback from a patient perspective, i.e. they made comments on things that they assume to be not intuitive or understandable for patients instead of focusing on their role as nurses.

Another issue is that the “potential users” were not hospitalized and were recruited from the authors’ environment. Regarding usability, we consider these persons as representative since we selected persons randomly not requesting specific technical skills. However, people might conceive things differently when they are really inpatients. We tried to balance the age groups of persons involved in our test and could not determine differences in the feedback depending on the age of the user. As mentioned earlier, the inpatients of the collaborating hospital are older than 60 years. A field study has to be performed to ensure that inpatients can deal with the systems without problems.

A comparison between the whiteboard version and the digital version was not performed. Since the digital version of the patient board contains the same information as the current markerboard version of the patient board, we believe that the information is at least understandable to a similar extent. However, we did not verify this within our usability test.

Future Extensions and Integration with other Digital Boards

As mentioned in the concept section, we envision to digitize additional lean boards. There is already one commercial

product available that digitizes the huddle board (http://www.cistec.ch/abteilungsboard/). It supports an interactive shift scheduling in a ward. Additional functionalities of that board are:

- Providing an overview of the rooms and beds as well as the patients.
- Information from the patient record can be displayed directly on the board (configurable).
- Shift planning: By integrating the planning information from the PEP into the board, the employees of a shift are automatically displayed. These can then be assigned to the patients.
- Planning entries/exits.

The board has been implemented in one Swiss hospital [8] and has been in use since July 2018. We are currently digitalizing the flowboard. Once this is completed, all three boards can be integrated ensuring the best possible data integration and reuse. Questions concerning storage and remarks from patients in the HIS could help in understanding communication problems among patients and healthcare staff.

Conclusions

Lean management is going to be implemented in hospitals to better deal with available resources. In its current implementations, however, optimization potentials exist that could be addressed by means of digital solutions. We introduced our concept for a digital patient board as one crucial component of the lean hospital. The usability test confirmed good usability. Data can be automatically retrieved from information systems.

In future, in particular, the patient tablet as one out of several devices of our concept can be equipped with additional features, such as menu selection, or features for patient education. However, it has to be ensured that patients only see content that is relevant for them and which they can handle. We believe that the standard version of the digital patient board should focus on the information provided by the current patient board. Advanced users should be enabled to use additional functionalities.

Acknowledgements

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